Case Report Rapport de cas

Acute intraparenchymal spinal cord injury in a cat due to high-rise syndrome

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Abstract — A 9-year-old spayed female Bengal Red cat was evaluated for high-rise syndrome. The cat had paraplegia of the hind limbs, intact reflexes and pain perception, and hyperesthesia in the caudal thoracic area. Mentation, cranial nerve function, forelimb proprioceptive responses, and spinal reflexes were normal. There were no abnormalities on radiographs or computed tomography scan, but magnetic resonance imaging revealed a hyperintense intraparenchymal spinal cord lesion on T2-weighted and T2 fat saturation images.

Résumé — Dommage aigu intraparenchymateux de la moelle épinière chez un chat à cause du syndrome des hauteurs. Une lésion intramédullaire hyperintense a été diagnostiquée chez une chatte stérilisée de 9 ans, de race Bengale Rouge, évaluée pour défenestration. L'examen neurologique a révélé une paraplégie, une douleur profonde conservée et des réflexes spinaux normaux. Une hyperesthesie était présente dans la région thoracique caudale. L'état mental, les nerfs crâniens, les réflexes spinaux et la proprioception des 4 membres étaient intacts. Aucune anomalie n'a été détectée sur les radiographies ou à l'examen par tomodensitométrie. La résonance magnétique a joué un rôle primordial dans l'établissement du diagnostic du patient, en révélant la présence d'une lésion intramédullaire sur les images pondérées en T2 et FSE (Fat Spin Eco).

(Traduit par Dr. Alice Defarges)

Can Vet J 2012;53:274–278

Intraparenchymal spinal cord injury appearing hyperintense on magnetic resonance imaging (MRI) has been reported in dogs, cats, rabbits, and humans (1–11). Most cases of hyperintense intraparenchymal spinal cord lesions reported in dogs have been associated with intervertebral disk herniation or ischemic myelopathy. In dogs and cats, intraparenchymal spinal cord hyperintensity has been reported to be associated with fibrocartilaginous embolism, acute spinal cord infarction, and intervertebral disk extrusion (1–10). A hyperintense spinal cord lesion was diagnosed in a rabbit after a fall, with no evidence of spinal cord compression despite the vertebral fracture seen on radiography (11). Magnetic resonance imaging has played an important role in providing an accurate diagnosis in patients with blunt trauma, compressive myelopathy, and neoplasia (12). In humans, the term spinal cord injury without radiographic abnormalities (SCIWORA) was introduced in the medical literature in 1982, before the widespread use of MRI, to describe cases with neurologic abnormalities following a traumatic event, but with normal radiographs and computed tomography (CT) scans (13). However, with the introduction of MRI, this term has lost much of its validity, and a patient with spinal cord injury should now only be diagnosed with SCIWORA if no abnormalities are found on any radiologic investigation including MRI (14).

In cats, the most common abnormalities reported due to high-rise syndrome include fractured limbs (more commonly hind limbs than forelimbs), thoracic trauma (pneumothorax and pulmonary contusions), and abdominal trauma (15,16). Most cats with acute spinal trauma have an associated vertebral fracture, subluxation, luxation, and ischemia or disk extrusion (17). To the authors' knowledge, neurologic symptoms and spinal cord trauma after high-rise syndrome are infrequently reported. This case report describes the radiological picture (plain radiography, CT, and MRI) of trauma to the spinal column and spinal cord in a cat with high-rise syndrome.

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Case description

A 9-year-old spayed female Bengal Red cat was presented to the Ontario Veterinary College Teaching Hospital (OVC-TH) of the University of Guelph, for the evaluation of bilateral hind limb paralysis after a 16-meter fall from a 6th storey balcony. The cat was found lying on the grass. On presentation the cat was quiet but responsive. The cat had luxated patellas and hematuria of unknown origin. Neurological evaluation performed on arrival at OVC-TH showed paraplegia of the hind

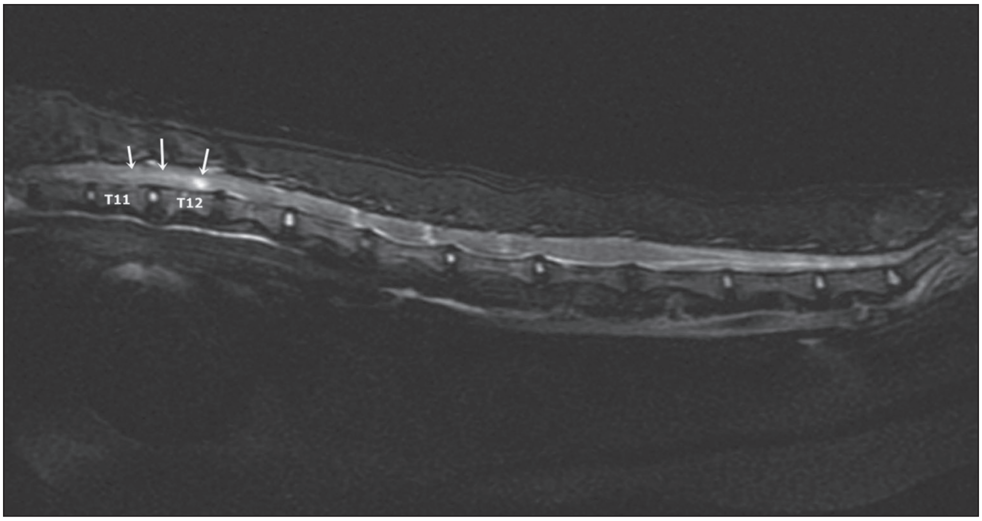

Figure 1. Sagittal T2 fat saturation spin echo weighted MRI image of the lumbar spine of a cat after high-rise syndrome. A focal well-defined hyperintense lesion is present in the spinal cord from the caudal aspect of T12 to the level of T11.

limbs with intact spinal reflexes and proprioceptive response. Hyperesthesia was identified in the caudal thoracic area. The cat had normal mentation, cranial nerve function, and forelimb proprioception. Deep pain was present in the right hind limb and absent in the left. Urinary and fecal control was present. The neuroanatomic location of the lesion was determined to be at spinal level T3–L3. Radiography, MRI, and CT were performed approximately 12 h after the accident, to evaluate bone abnormalities, and spinal cord injuries.

Imaging findings

Radiography

Orthogonal radiographic projections of the thoracolumbar and lumbar spine were obtained using a computerized radiography system (Agfa CR System, Agfa HealthCare, Albuquerque, New Mexico, USA). No radiographic abnormalities indicating subluxation or fracture were detected on any of the radiographic projections. Despite the absence of radiographic abnormalities, additional views in flexion or extension positions were not attempted, due to the risk of exacerbating the spinal cord lesion. Instead, since the neurologic signs indicated a spinal cord lesion, an MRI was performed immediately after the radiographs were taken.

Magnetic resonance imaging findings

Magnetic resonance imaging evaluation of the thoracolumbar vertebral column was carried out using a 1.5 Tesla superconducting magnet (General Electric Signa LX 1.5 Tesla MR HiSpeed Plus System, GE Medical Systems, Milwaukee Wisconsin, USA). Images acquired included T2-weighted fast spin echo images in the sagittal, transverse, and dorsal planes; T2-weighted fat saturation fast spin echo and gradient recall echo (GRE) images (obtained in the transverse plane); T1-weighted fast spin echo images before contrast administration; and T1-weighted fat saturation images after contrast administration. The dorsal, transverse, and sagittal images had slice thicknesses of 2 mm, 3 mm, and 2 mm, respectively.

On the T2-weighted images, a focal hyperintense intramedullary lesion was observed in the spinal cord extending from the mid-body of T11 to the caudal end plate of T12 (spinal cord segments T11–T12). The hyperintense lesion was more conspicuous on the fat-saturation T2-weighted images (Figure 1) involving approximately 2.1 cm of the spinal cord. The hyperintense lesion involved approximately 50% of the cross-sectional area of the spinal cord over 6 consecutive slices (Figures 2 A, B, C). These images also showed hyperintense lesions in the epaxial muscles from the cranial endplate of T10 to the caudal endplate of T12 (Figures 2A and 2B), but the vertebral bodies remained hypointense. The intervertebral disc at T11-T12 appeared normal, showing centrally located high signal intensity. The intervertebral discs T12–13 and L4–5 showed decreased signal intensity on T2-weighted images. Mild protrusion of the intervertebral disc (type 2 disc disease) was noted at T12–T13 and L4–L5, but no spinal cord compression was identified on transverse plane images (Figures 2 A, B, C). No abnormalities were noted on GRE-weighted images, and no abnormal signal intensities were observed in the bony structures.

These findings led to a diagnosis of acute traumatic hyperintense lesion caused by myelopathy. The spinal cord edema extending from the caudal end plate of T12 to the mid-body of T11 was a result of spinal column contusion. The hyperintense lesion in the epaxial muscles, representing muscle edema, was evidence of the traumatic event. Differential diagnosis of the MRI findings includes spinal cord contusion due to high velocity, low volume intervertebral disc extrusion or hyperextension/hyperflexion of the vertebral column, and ischemia due to fibrocartilaginous embolism or vascular injury/spasm. The lack of susceptibility artifact (low signal) on the T2* GRE sequences indicated the absence of acute hemorrhage. There were no changes in the medullary cavity of the vertebral bodies seen on the MRI scan that could be related to the presence of fractures or subluxation. However, the relatively large slice thickness did not allow exclusion of a small non-displaced fracture; a CT study was therefore carried out.

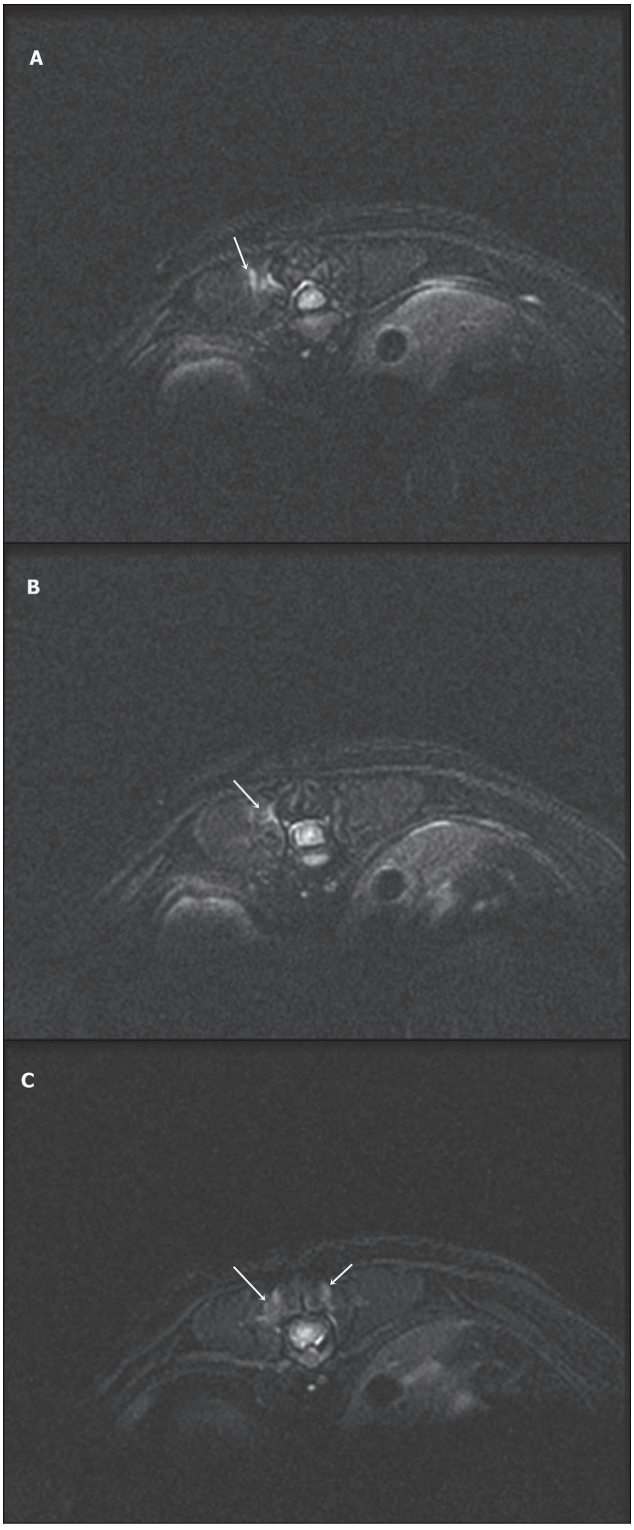

Figure 2. Transverse T2 fat saturation spin echo weighted image at T11 (A), T11–T12 (B), T12 (C). A hyperintense lesion is observed in the spinal cord at the above-mentioned vertebral column levels. A hyperintense lesion (arrows) is also observed in the epaxial muscles on the left side in A, B, and C.

Computed tomography

A CT examination of the thoracolumbar spine was performed using a 4-slice CT scanner (GE LightSpeed QX/I 4 Slice CT; GE Medical Systems). Contiguous 1.25 mm-thick transverse plane images were acquired from T11–L3. Sagittal and dorsal reconstructed images were also generated. No abnormalities were noted within the bone structures that would indicate subluxation, fracture, or extruded discs in the transverse, sagittal, or dorsal plane images. The 3 spinal compartments were within normal limits.

Based on the absence of osseous abnormalities in radiographs or CT scans, and the hyperintense lesion in the spinal cord found on MR, a diagnosis of acute spinal cord injury due to high-rise syndrome was made. Radiographs were taken first, to rule out obvious osseous abnormalities that might have been the cause of spinal cord trauma. Stress views were not attempted due to the risk of exacerbating intramedullary lesions, considering the possibility of spinal column instability that was not identified on the radiographs. This led us to believe that an intraparenchymal spinal cord lesion was the most likely abnormality; MRI was chosen as the second imaging modality for a more detailed evaluation of the spinal cord. Once the hyperintense lesion was found on MRI, even though we did not see any evidence of musculoskeletal lesions, a CT study was carried out to exclude minor musculoskeletal abnormalities.

After imaging studies were done the cat recovered well from anesthesia and was hospitalized for exercise restriction and pain management. A urinary catheter was removed and the bladder was easily expressed. Urine culture revealed the presence of bacteria and antibiotic therapy was initiated. At the time of discharge (7 d after admission) the patient was paraparetic with purposeful movement in the pelvic limbs bilaterally that was stronger on the right hind limb. The cat was able to urinate on her own but occasionally needed to have her bladder expressed.

To the authors' knowledge, such a spinal cord injury after high-rise syndrome has not been described before. The cat was treated conservatively with exercise restriction (cage rest for 2 wk followed by gradual re-introduction to exercise) and pain medication (Tramadol 5 mg capsules; compounded at OVC Pharmacy, University of Guelph), 1 capsule, PO, q12h, as needed.

Clinical follow-up

Several rechecks at OVC-TH after the first presentation, and phone conversations with the owner indicated slowly progressive neurologic improvement. The final follow-up examination at OVC-TH 3 mo after initial presentation demonstrated that the patient was more stable when walking and showed attempts to run. According to the last phone conversation with the owners 5 mo after initial presentation the cat was free from obvious signs of pain and was walking and running normally. The cat had voluntary urination although sometimes the bladder needed to be expressed manually.

Discussion

Acute spinal cord injury is a common condition in small animals, and the cause can be either traumatic or vascular (17). Vertebral fractures and/or luxations as well as intervertebral disc extrusion are frequent after direct trauma (17). Even in the absence of radiographically evident fractures or luxations, the patient may have spinal cord concussion due to direct trauma from hyperextension/hyperflexion or from high-velocity intervertebral disk herniation (17). In the cat described here, the hyperintensity observed on MRI was probably due to spinal cord edema secondary to concussion or ischemia due to direct trauma. This conclusion was drawn since the intervertebral disc was normal in volume, no extradural material was present in the vertebral canal, and no spinal column instability or fracture was detected. Flexion or extension stress radiographs were not taken in the present case, since minimal manipulation of the spinal column is recommended in cases of suspected spinal injury (17). It has been suggested that if there is no progression of clinical signs 72 h after the injury, the probability of spinal instability is lower (18).

When survey radiography in the trauma patient does not show abnormalities, additional imaging methods such as myelography, CT, CT-myelography, or MRI are recommended to evaluate spinal cord swelling and extradural compression (17,18). The value of MRI in the work-up of a patient with spinal column trauma is widely accepted in human medicine (19–21), but its role in spinal trauma has not been established by a case control study in veterinary medicine. In the human literature, MRI is said to be superior to CT in the investigation of spinal cord injury, extradural lesions, and ligamentous injuries; characterization of spinal fractures (acute versus chronic); and diagnosis of multilevel injuries of the spine, as it provides information on the character and extent of intramedullary lesions (19–21). Therefore, suggested indications for performing MRI in patients with spinal trauma include the presence of neurologic signs, the cause of which cannot be found on CT or CT myelogram, a suspected spinal cord lesion, suspected presence of an extradural hematoma, disc herniation that cannot be detected on CT or CT myelogram, and the absence of improvement or deterioration of clinical signs in the time after the accident (20).

In cats, it has been determined that MRI may be an important diagnostic tool when neurologic dysfunction is severe and when prognosis needs to be defined (8). The role of MRI in the evaluation of patients with spinal cord trauma is dual: the first is to evaluate the extent of the trauma to the nervous tissues (spinal cord, nerve roots). Human medicine has demonstrated a correlation between the degree of severity of the spinal cord lesion seen on MRI and neurologic dysfunction. Determination of the approximate number of spinal cord segments involved also facilitates the determination of prognosis in patients with spinal cord trauma. In humans, it has been reported that the neurologic condition tends to improve if the hyperintense pathology is focal rather than extensive (20). This has been also reported in a study of dogs with hyperintensities in the spinal cord following intervertebral disk extrusion (22). In the case reported here, only approximately 2 segments were found to be affected on the MRI, which might explain the successful recovery with medical treatment.

The other important role of MRI in spinal column trauma is to evaluate musculoskeletal and ligamentous lesions (21). This will indicate the mechanism of injury and, more importantly, suggest an approach for treatment planning and prognosis (21). In the current patient, MRI demonstrated epaxial muscle edema, suggesting a traumatic event. The contrast resolution of MR is superior to that of CT, and T2-weighted fat suppression techniques nullify the signal from the fatty marrow cavity. This allows easy detection of edema in the vertebra, which serves as an indicator of bone trauma or acute injury. The most important finding is high signal intensity changes in the bone marrow on T2-weighted images, which are indicative of a subtle acute fracture. Here, MRI did not suggest a fracture, based on the absence of hyperintense signal within the bone marrow of the vertebral bodies. However, the lack of case control studies in veterinary medicine evaluating the role of MRI in spinal trauma led to the decision to perform a CT to completely rule out the possibility of vertebral fractures and/or subluxation. In veterinary medicine, radiography, myelography, and CT-myelography seem to be the first steps to evaluate patients with spinal column trauma (23).

High-rise syndrome is a term used to describe feline patients with injuries inflicted by a fall from a building that is at least 2 storeys high. A case series reported that the most common abnormalities due to high-rise syndrome include fractured limbs and thoracic trauma, followed by pneumothorax and pulmonary contusion (15). In the case reported here, there were no fractures or thoracic trauma. Splenic rupture along with thoracic and abdominal impalement in 3 cats secondary to high-rise syndrome have been also reported (16). Other common lesions include facial trauma, mandibular and maxillary fractures, and the less common diaphragmatic hernia and rupture of the urinary bladder (15). In a retrospective study on 30 cats with thoracolumbar spinal cord injury due to trauma, 2 of the injuries were reported to be secondary to a fall, but not specifically associated with high-rise syndrome. These 2 cats were diagnosed with spinal cord swelling on myelography. They recovered well following medical treatment. (24).

A possible explanation for the type of injury that the cat sustained (compared with fracture/subluxation) may be that cats seem to have more spinal flexibility than other species (25). The degree of mobility of the spinal column varies depending on the part of the spine involved and the species. As in humans, the cervical and cranial thoracic spinal columns in animals are more mobile than the caudal thoracic spinal column (26).

Even though the dose of Tramadol used in this patient seems to be slightly lower than the recommended dose for cats (27) it was effective in keeping the patient free of pain during recovery. The rationale for use of this dose was to minimize potential important side effects of Tramadol, which are respiratory depression, bradycardia, urine retention, ileus, and decreased temperature (28).

In conclusion, high-rise syndrome may be associated with spinal cord trauma. Magnetic resonance imaging seems to play an important role in the evaluation of patients with spinal trauma when no fracture or subluxation is detected on radiographs or CT; however, this should be further investigated in a case-control series. Thus, the initial imaging diagnosis work-up in patients with spinal column trauma would be plain radiography, myelography, and CT-myelography, bearing in mind that MRI may be necessary to more thoroughly investigate a suspected spinal cord lesion when no abnormalities are found on roentgenograms. CVJ

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References

1. Grunenfelder FI, Weishaupt D, Green R, et al. Magnetic resonance imaging findings in spinal cord infarction in three small dogs. Vet Radiol Ultrasound 2005;2:91–96.
2. Levine JM, Fosgate GT, Chen AV, et al. Magnetic resonance imaging in dogs with neurologic impairment due to acute thoracic and lumbar intervertebral disk herniation. J Vet Intern Med 2009;23:1220–1226.
3. Sanders SG, Bagley RS, Gavin PR. Intramedullary spinal cord damage associated with intervertebral disk material in a dog. J Am Vet Med Assoc 2002;221:1594–1596.
4. De Risio L, Adams V, Dennis R, et al. Association of clinical and magnetic resonance imaging finding with outcome in dogs with presumptive acute noncompressive nucleus pulposus extrusion: 42 cases (2000–2007). J Am Vet Med Assoc 2009;234:495–504.
5. Chang Y, Dennis R, Platt SR, et al. Magnetic resonance imaging of traumatic intervertebral disc extension in dogs. Vet Rec 2007;160:795–799.
6. Besalti O, Pekcan Z, Sirin YS, et al. Magnetic resonance imaging findings in dogs with thoracolumbar intervertebral disk disease: 69 cases (1997–2005). J Am Vet Med Assoc 2006;228:902–908.
7. Abramson CJ, Garosi L, Platt SR, et al. Magnetic resonance imaging appearance of suspected ischemic myelopathy in dogs. Vet Radiol Ultrasound 2005;46:225–229.
8. Goncalves R, Platt SR, Llabres-Diaz FJ, et al. Clinical and magnetic resonance imaging findings in 92 cats with clinical signs of spinal cord disease. J Feline Med Surg 2009;11:53–59.
9. MacKay AD, Rusbridge C, Sparkes AH, et al. MRI characteristics of suspected acute spinal cord infarction in two cats, and a review of the literature. J Feline Med Surg 2005;7:101–107.
10. Lu D, Lamb CR, Wesselingh K, et al. Acute intervertebral disc extrusion in a cat: Clinical and MRI findings. J Feline Med Surg 2002;4:65–68.
11. Beaufrere H, Cruz R, Smith DA, et al. Imagerie par resonance magnetique nucleaire sur un cas de traumatisme spinal chez un lapin de compagnie. Prat Med Chir Anim 2009;44:23–26.
12. Pang D. Spinal cord injury without radiographic abnormality in children, 2 decades later. Neurosurgery 2004;55:1325–1343.
13. Van Buul G, Oner FC. Thoracic spinal cord injury without radiographic abnormality in an adult patient. Spine J 2009;9:e5–e8.
14. Yucesoy K, Yuksel KZ. SCIWORA in MRI era. Clin Neurol Neurosurg 2008 May;110:429–433.
15. Vnuk D, Pirkić B, Maticić D, et al. Feline high-rise syndrome: 119 cases (1998–2001). J Feline Med Surg 2004;6:305–312.
16. Pratschke KM, Kirby BM. High rise syndrome with impalement in three cats. J Small Anim Pract 2002;43:261–264.
17. Vitale CL, Coates JR. Acute spinal cord injury. Standards of Care, Emergency and Critical Care Medicine 2007;9:1–11.
18. Negrin A, Schatzberg S, Platt S. The paralyzed cat. Neuroanatomic diagnosis and specific spinal cord disease. J Feline Med Surg 2009;11: 361–372.
19. Parizel PM, van der Zijden T, Gaudino S, et al. Trauma of the spine and spinal cord: Imaging strategies. Eur Spine J 2010;19:S8–S17.
20. Green RAR, Saifuddin A. Whole spine MRI in the assessment of acute vertebral body trauma. Skeletal Radiol 2004;33:129–135.
21. Phal PM, Anderson JC. Imaging in spinal trauma. Semin Roentgenol 2006;41:190–195.
22. Ito D, Matsunaga S, Jeffery ND, et al. Prognostic value of magnetic resonance imaging in dogs with paraplegia caused by thoracolumbar intervertebral disk extrusion: 77 cases (2000–2003). J Am Vet Med Assoc 2005;227:1454–1460.
23. Sturges BK, LeCouteur RA. Vertebral fractures and luxations. In: Douglas Slatter, ed. Textbook of Small Animal Surgery. 3rd ed. St. Louis, Missouri: Elsevier Science, 2002:1244–1261.
24. Grasmueck S, Steffen F. Survival rates and outcomes in cats with thoracic and lumbar spinal cord injuries due to external trauma. J Small Anim Pract 2004;45:284–288.
25. Colville J, Ellwein A. The skeletal system. In: Colville T, Bassert JM, eds. Clinical Anatomy and Physiology Laboratory Manual for Veterinary. 2nd ed. St. Louis, Missouri: Elsevier Health Sciences, 2008:95–144.
26. Dyce KM, Sack WO, Wensing CJG. The locomotor apparatus. In: Dyce KM, Sack WO, Wensing CJG, eds. Textbook of Veterinary Anatomy. 3rd ed. Philadelphia, Pennsylvania: Saunders, 2002:32–99.
27. Gaynor JS. Other drugs used to treat pain. In: Gaynor JS, Muir WW, eds. Handbook of Veterinary Pain Management. St. Louis, Missouri: Mosby, 2002:251–260.
28. Beckman BW. Pathophysiology and management of surgical and chronic oral pain in dogs and cats. J Vet Dent 23:50–60.